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ABSTRACT

This paper begins by reviewing the results of research on the potential of adjunct questions for teaching both rote recall and intellectual skills, i.e., concept learning, problem solving, and rule learning. It is argued that greater understanding of what kinds of questions best support intellectual skills learning will promote effective instructional design while adding to current knowledge of the learning process. The view that the successful learner takes an active role in the learning process is a major assumption inherent in the framework that is presented for conceptualized research in this area. This view is discussed in terms of the constructivist and generative conceptions of learning with references to assimilation theory, mathemagenic views of learning, cognitive strategy activators, and the information processing model. It is noted that this framework addresses three superordinate factors involved in the learning process: (1) design of stimulus material; (2) active role of the learner; and (3) nature of the learning outcome. A research study planned for the spring of 1991 is then described which will explore the differential effects on learning of three types of adjunct questions incorporated in a text lesson on basic statistical concepts and rules. (The treatments for this study are derived from three separate theoretic perspectives--assimilation theory, forward transfer theory, and cognitive strategy activation--and the subjects will be 80 graduate students at San Jose State University in California.) Suggested topics for future research conclude the paper. (3 figures, 31 references) (BBM)

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Adjunct Questions and Rule Learning

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Educators tend to agree about the criticality of integrating questions in learning material. Questions provide learners with opportunities to apply or process the content of instruction, thereby supporting learning. Early research demonstrated that adjunct questions do have positive influences on acquisition and retention of factual information (Hamilton, 1986; Rickards & Denner, 1978; Watts & Anderson, 1971).

Recent authors--looking beyond verbal information learning--have expressed interest in the potential of adjunct questions to facilitate learning in the intellectual skills domain (cf. Andre, Mueller, Womack, Smid, & Tuttle, 1980; Jonassen, 1985; Carrier & Fautsch-Patridge, 1981). The present discussion considers this research area and offers the following: 1) a rationale for pursuing research regarding the effects of adjunct questions on rule learning; 2) a framework for conceptualizing such research; 3) a description of a related research study; and 4) general recommendations for future research.

Adjunct Questions and Intellectual Skills: Why Bother?

The usefulness of continuing to investigate how questions influence rote recall has been challenged. As early as 1971, Watts and Anderson noted, "Whether or not a student is able to accurately recognize... strings of words is educationally trivial" (p. 387). Others extend this argument, stating that the practical educator should be more concerned with whether students understand concepts and principles than whether they can recall factual details (Anderson & Biddle, 1975). These views are indicative of the interest that presently exists concerning use of adjunct questions to support learning in the intellectual skills domain as described by R. Gagne (1985). Intellectual skills include concept learning, rule using, and problem solving.

Existing research provides a second more specific reason for pursuing research in this area. Minimal consensus has emerged from the research that has addressed the impact of adjunct questions on intellectual skill learning. Studies concerned with concept learning illustrate this point. Some studies have indicated that adjunct questions questions facilitate concept learning (cf., Watts & Anderson, 1971; E. Gagne, Broughton, Eggleston, Holmes, Hawkins, & Sheldon,1979). Others have not.

In their seminal study, Watts and Anderson (1971) had subjects answer one of three types of questions. These questions entailed either identifying a previously presented example of a principle described in the text, identifying a new example of a principle, or identifying the name of the person associated with a given principle. Results indicated that application questions requiring identification of new examples facilitated subjects' ability to identify previously unencountered examples of the

presented concepts. The researchers refer to the idea of *levels of processing* in suggesting that "... subjects answering application questions... were forced to engage in more thorough processing of the passages" (p. 392). They further note that application-level questions probably induced subjects to review passages in a manner that produced the deeper processing.

A study conducted by E. Gagne et al. (1979) also demonstrated the positive effects that higher-order questions may have on learning. In this study, subjects read passages on the concepts of autism and trochaic meter. Following each passage, subjects answered one of four types of questions requiring them to either summarize the passage, generate a new example of the concept, list the critical attributes of the concept, or identify a new example of the concept. Results support the view that adjunct questions requiring subjects to identify new examples facilitated successful classification of instances of the given concepts. The authors suggest that the questions accompanying the text included "close-in nonexamples" (p. 305) which may have caused subjects to carefully discriminate concept attributes.

Other authors dispute the view that adjunct questions promote concept learning. Andre et al. (1980) investigated whether including application questions in instruction would increase subjects' ability to apply the concepts being learned. Results of these and other studies (cf. Bing, 1982; Hamilton, 1986) appear to contradict the intuitively appealing idea that adjunct questions requiring subjects to apply content will result in superior criterion performance over either recall questions or no questions. While Andre and associates acknowledge the assumptions educators make about the perceived importance of asking higher-order questions, they conclude that "...there is little evidence that later application is influenced by the type of adjunct question" (p. 542). Hamilton offers a similar conclusion.

The confusion regarding the effects of adjunct questions on concept learning is indicative of the need for further research. Greater understanding of what kinds of questions best support intellectual skill learning will promote effective instructional design while adding to our knowledge of the learning process.

Active Role of the Learner

An overarching framework for conceptualizing research in the area of interest is presented in Figure 1. A major assumption inherent in the framework is this: the successful learner takes an *active* role in the learning process. Consistent with a general cognitive orientation toward research, this view is further reflected in the constructivist and generative conceptions of learning that some have offered.

insert Figure 1 here

The constructivist view holds that the learner builds new understanding and knowledge on the basis of existing knowledge (Pea, 1988). Motivational factors such as the perceived relevance of the instructional content (see Keller, 1983) also affect the degree of effort put forth by the learner in processing the presented information. This outlook is consistent with the so-called generative view of learning.

In a discussion of generative learning, Wittrock (1984) suggests that "... learners construct their own meaning from teaching" (p. 124). Thus learning with understanding requires that one determine the structure of what is to be learned and then generate relationships among the components. Further, learning is enhanced "...by constructing relationships between something familiar and something to be remembered" (p. 123).

Assimilation theory as described by Mayer (1980) is also consistent with the constructive and generative views. According to this theory, the key aspects of learning include receiving the to-be-learned material and activating an assimilative context grounded in meaningful, related past experience. All three perspectives--the constructivist, generative, and assimilative--stress that students must actively relate new information to existing knowledge if learning is to occur. This is sometimes referred to as the process of *elaboration* (Mayer, 1984; Jonassen, 1985).

At a conceptual level, it is useful to distinguish between the generative and mathemagenic views of learning as discussed by Jonassen (1985). The mathemagenic hypothesis essentially attributes meaningful learning to "...certain design attributes..." (p. 9) of the instruction such as adjunct questions that are conceived to induce the cognitive processes that are requisite to learning. Jonassen notes that this view "...assumes that learners are better led to learning than allowed to determine the relevance or meaning of material themselves" (p. 10). Conversely, the generative view asserts that learners confronting new information in instruction "... construct and assign meaning to that information based upon prior learning" (p.11).

Reigeluth (1983) notes the possibility of reconciling these two views via inclusion of cognitive strategy activators within instruction. These may be direct, embedded activators such as diagrams or analogies, or they may be or less direct, detached activators that advise the student to apply a given cognitive strategy (e.g., "Draw a diagram showing the relationship explained in the previous section"). Embedded activators are consistent with the mathemagenic conception of learning, detached activators with the generative view.

Information Processing

A now ubiquitous information processing model (IPM) provides further theoretical basis for conducting research on learning from text. This model has been previously described by a number of authors (cf. Reed, 1982; R. Gagne, Briggs, & Wager, 1988; Mayer, 1984). Derived from the work of Atkinson and Shiffrin (1968) and others, the IPM "... posits internal structures of the human learner and the kinds of processing accomplished by each of these structures (R. Gagne, 1985, p. 70). Figure 2 summarizes the generally agreed upon processes inherent in meaningful information processing.

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insert Figure 2 here

Successful encoding appears to be the key to adequately processing and later remembering information (cf. R. Gagne, 1985; Mayer, 1984; Siegler & Klahr, 1982). Craik and Lockhart (1972) stressed the criticality of encoding when they introduced the notion of "levels of processing." According to this view, memory is directly influenced by the nature and degree of encoding operations carried out by the learner (Reed, 1982).

Meaningful, semantic-based encoding is said to produce greater memory than non-semantic encoding (Andre, 1979). According to this view, questions that increase the meaningfulness of information should facilitate learning (W. Wager & S. Wager, 1985). Elaboration--one activity a learner may complete while processing information--is theorized to increase meaningfulness and to support the crucial process of encoding (R. Gagne & Glaser, 1987; Mayer, 1980)

Two critical control processes that are integrated in some information processing models (see R. Gagne et al., 1988). Executive control and expectancies are processes that are said to "...activate and modulate the flow of information during learning" (p. 10). Executive control refers to the learner's self-guided selection and use of cognitive strategies that support encoding and learning. Expectancy refers to the idea that the learner's awareness of the goals and objectives of instruction influence perception, encoding, and subsequent performance.

In sum, the presented framework addresses three superordinate factors involved in the learning process. These are briefly summarized here:

1) **design of stimulus material:** adjunct questions or cognitive strategy activators are design features of the presented instruction that should support learning; other factors such as

the layout, organization, or motivational appeal of the material may also influence learning;

2) **active role of learner:** the student's role may no longer be equated with the dash in the stimulus-response (S-R) or behaviorist conception of learning; the learner must actively process new information, elaborating and employing various cognitive strategies in light of expectations if meaningful learning is to occur;

3) **nature of the learning outcome:** future research may be most useful when it considers how various designs of adjunct questions influence learning of intellectual skills rather than rote fact learning: the functional usefulness of learning provides one possible indicator of the so-called ecological validity of research.

Description of Related Research

The present author is currently planning a research study that will be conducted in the spring of 1991. The purpose of the study is to ascertain the differential effects on learning of three types of adjunct questions incorporated in a text lesson on basic statistical concepts and rules. Treatments are derived from three separate theoretic perspectives: assimilation theory, forward transfer theory, and cognitive strategy activation.

Assimilative Context Activation

The *context activation* version of the instruction will include questions designed to require activation of an assimilative context as discussed by Mayer (1980). These are questions requiring that subjects relate the subject content to their own previous experience in providing a short written answer.

Assimilation theory entails three key processes conceived to support learning. First is the idea of reception: the learner must focus attention on information presented in the text in order for it to enter short term memory. Second is the idea of availability: the learner must have relevant existing knowledge that can serve as an assimilative context in order to relate what is being learned to what is already known. Third is the idea of activation: the learner must actively relate information in the instruction to existing knowledge--that is, to the assimilative context.

Consistent with the views of Mayer (1980) and other theorists (Weinstein & Underwood, 1985; E. Gagne, 1985), the present study builds upon the view that engaging learners in elaborative processing activities will

facilitate learning. Mayer argues that elaborative activities should produce broad, integrated knowledge structures that are consistent with rule learning. This theoretical perspective predicts that asking questions to promote active integration of the to-be-learned information with existing knowledge will affect encoding so as to improve the learner's ability to apply what was learned in tasks requiring application of intellectual skills.

Expectancy Clarification

A second experimental treatment--the *expectancy clarification* version--includes questions that require subjects to make short answer responses at various points about the goals of the instruction.

Studies by Reder, Charney, and Morgan (1986) and Mayer (1975) reveal that informing the learner of criterion tasks at the start of instruction can positively influence learning. The present study builds upon these findings by considering the relative effectiveness of questioning learners about learning tasks rather than just informing them.

The theoretical basis for questioning students about criterion tasks--while consistent with the attentional aspect of assimilation theory--is primarily derived from forward transfer theory. This view holds that if learners encounter questions of a particular type at the beginning of or within a text passage, they will be prompted to adopt a processing strategy in later passages consistent with the nature of the previously given questions (Sagerman & Mayer, 1987). Learners may continue to apply the adopted reading strategy even when questions cease.

This treatment is also consistent with the work of R. Gagne (1985; R. Gagne, et al., 1988) and others regarding the usefulness of informing learners of objectives in order to establish an expectancy which may serve to guide encoding of the instructional material.

Cognitive Strategy Activation

The third treatment--the *cognitive strategy activation* version--includes directives that suggest that subjects paraphrase key ideas in the instruction. A number of theorists have expressed interest in the use of such directives or "detached cognitive strategy activators" in instruction. Reigeluth (1983), for instance, makes the following comment:

> ...it is not necessary for all learners to have learned a cognitive strategy in order for its corresponding detached activator to improve the quality of the instruction. In fact, since such an activator is so short a piece of the instruction, it may be cost-effective to include it even if just a few students can benefit from it. (p. 213)

Others such as R. Gagne (1986) have indicated that questions designed to induce application of various cognitive strategies is an area that merits exploration. Gagne comments that "...the learner can be asked to *supply* an elaboration by summarizing, by supplying examples, or in some other way" (p. 13).

The planned study considers the relative effectiveness of including adjunct questions in text designed to prompt learners to paraphrase lesson content. Numerous authors have identified paraphrasing as an elaboration technique that should facilitate encoding and learning (cf. R. Gagne et al., 1988; R. Gagne, 1986; Weinstein & Mayer, 1986; Weinstein & Underwood, 1985). Paraphrasing is expected to increase meaningfulness while providing additional cues for later retrieval. A fourth version serving as a control condition does not include any questions.

Subjects

Subjects will include 80 graduate students at San Jose State University in California. Subjects will participate in conjunction with taking an introductory course in educational research methods.

Dependent Measures

The posttest serving as the dependent measure includes questions that are distinct from those presented in the instructional material. These items require subjects to apply selected rules involving the normal distribution and interpretation and calculation of the standard deviation and z scores. Scores will be determined for the total test as well as for the three subcategories of questions: these include 1) calculation of the standard deviation; 2) calculation of z scores; and 3) interpretation of the standard deviation and z scores, respectively.

Qualitative data will also be collected and analyzed after subjects have completed the experimental material. This data will consist of results of eight interviews administered to the highest and lowest performers in terms of total posttest performance in each treatment group and the control group, respectively. A structured interview approach will be utilized to ascertain subjects' perspectives about the various versions of the instructional material, the learning tasks, and the effects of the adjunct questions.

Hypotheses

Hypotheses for the present study concern the relative effectiveness of the three types of adjunct questions in relation to the control condition.

Subjects answering either context activation, expectancy clarification, or cognitive strategy activation questions are expected to outperform subjects in the control condition. It is anticipated that the superior performance will be demonstrated in terms of the total posttest score as well as in terms of performance on the three subcategories calculation and interpretation questions. Figure 3 summarizes the expected effects of the various treatments.

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insert Figure 3 here

Directions for Future Research

What considerations should one keep in mind when planning adjunct-question research? This discussion closes with a few possibilities:

1) **learning of intellectual skills:** one can reasonably argue that sufficient research has been conducted involving "recall" as the dependent measure; understanding how questions and cognitive strategy activators may support higher-order learning seems like a more important and useful challenge;

2) **addressing methodological issues:** research should be designed to isolate how questions affect learning; some matters worth documenting in this regard include the amount of time subjects spend completing instruction, the number of adjunct questions that subjects answer correctly, and subjects' ability level in the given subject area. An indicator of ability level could potentially serve as a covariate in data analysis;

3) **employing qualitative approaches:** pure "experimental" approaches to research are no doubt useful; however, interviewing selected subjects after they complete a given treatment may provide additional insights regarding how questions influence the encoding process and help refine subsequent design approaches.

The refinement of questioning techniques in text-based instruction is an intriguing, worthy goal. Through continued research, we may be able to refine the theoretical and instructional design bases required to generate questions that help people learn useful skills in an efficient and meaningful manner.

Figure 1. **A Macro-Level Framework for Adjunct-Question Research**

INSTRUCTION <-->	LEARNER <-->	OUTCOME
External Events: Stimulus Material	Internal Events: Storage	Memory Structure: Performance
Lesson Structure: - Information - Questions - Feedback - Motivational Design	Information Processing: - Attention - Encoding - Elaboration - Rehearsal	Retrieval: - Procedural/ Declarative Knowledge - Functional Usefulness

Figure 2. **Information Processing: An Overview of Elements**

Element	Description
STIMULUS	learning material is designed, developed, released
PERCEPTION	learner encounters and perceives stimulus material through receptors
SELECTIVE PERCEPTION	learner attends to specific elements of the stimulus material
SHORT-TERM MEMORY	information which is the object of selective perception enters this internal structure
ENCODING	learner rehearses, integrates, applies or otherwise processes information in order to store and remember it
LONG-TERM MEMORY	information which is successfully encoded is stored in this internal structure
RETRIEVAL	learner recalls previously encountered information in response to test question or other cue
CONTROL PROCESSES	learner's expectancies about purpose of instruction and use of cognitive strategies while processing information influence encoding

Figure 3. **Hypothesized Influences of Question Types on Learning**

question type	cognitive activity	learning outcome
context activation	extensive elaboration: activation of assimilative context	strong performance on calculation and interpretive questions
expectancy clarification	increased attention and encoding of goal-related content	strong performance on calculation and interpretive questions
cognitive strategy activation	extensive elaboration via paraphrasing: redundant processing	strong performance on calculation and interpretive questions
none	minimal elaboration	poor performance on calculation and interpretive questions

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